# METAL CASTING

Project Fact Sheet

## MANUFACTURE OF SEMI-SOLID METALS (SSM) FEEDSTOCK

### BENEFITS

- Reduces cost of Semi-Solid Metal processing.
- 1.6 trillion Btu/year reduction in energy requirements due to elimination of intermediate ingot melting and the magneto-hydrodynamically/extra processing steps.
- Reduced energy requirements will reduce carbon dioxide emissions.

### APPLICATIONS

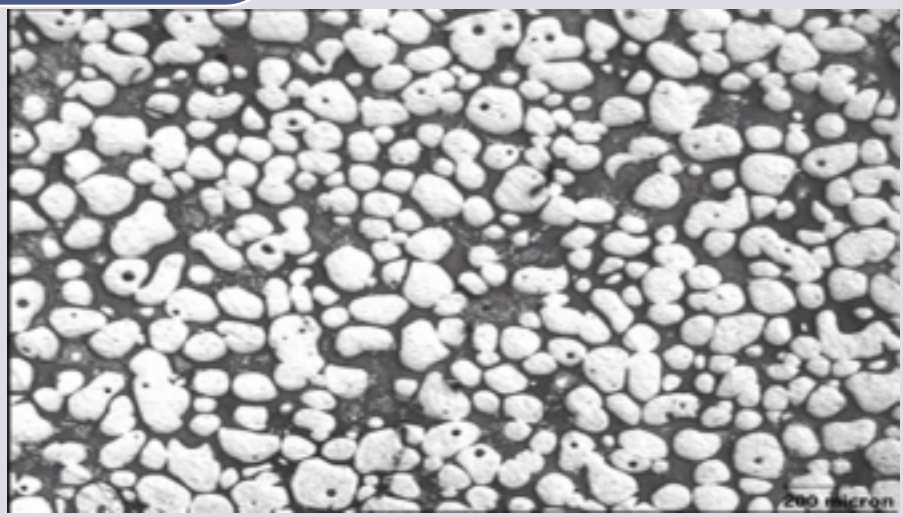
SSM processes can be used to produce near-net-shape castings such as those increasingly demanded by the automotive sector. The production of cheaper Semi-Solid Metals (SSM) feedstock will provide end users in the transportation industry with lighter, less expensive, high strength components.

## LOW COST AND ENERGY EFFICIENT METHODS FOR THE MANUFACTURE OF SEMI-SOLID (SSM) FEEDSTOCK

The Semi-Solid Metals (SSM) technology offers many benefits such as reduced turbulence in the die cavity, reduced defects and entrained oxides, and the ability to produce components with better mechanical properties compared to high-pressure die castings. The process has other ancillary advantages such as shorter cycle times, reduced energy consumption, and is environmentally friendly. Currently production requires magneto-hydrodynamically (MHD) stirred billets, or slurry on demand. It entails additional processing and melting of alloy stock, and produces billets that demand more energy.

The SSM Consortium at Worcester Polytechnic Institute (WPI) has provided grounds for fundamental, pre-competitive research in SSM. Research at WPI in semi-solid metal processing has produced results of fundamental and applied nature, which are available to the SSM community. These include material characterization, yield stress effects, alloy development, and other Semi-Solid Metal results. With the accumulated body of knowledge, WPI is investigating alternatives to produce SSM slurries at lower processing costs and with less energy. The concept proposed in this project will provide a low cost and an effective means of attaining a non-dendritic, globular SSM structure, which is thixotropic, and can thus be processed in the semi-solid state. The production of cheaper SSM feedstock could lead to a dramatic increase in the tonnage of castings produced by SSM, and will provide end users with lighter, cheaper, and better materials. In addition, less energy will be utilized because special billets will not be required and the off-all or returns will be usable as opposed to separated for reprocessing into special billets.

Better SSM Structures




**Near ideal A356 SSM structure produced by a process recently developed at MPI - the Continuous Rheoconversion Process**

## Project Description

**Goals:** The goals of this research are as follows:

- To develop and apply efficient grain refining methods to produce SSM billets with consistent characteristics at significantly lower cost premiums relative to methods currently in use.

- To carry computational and modeling studies of the fluid flow behavior of SSM slurries forward. Issues related to control of instabilities still remain and case studies will be developed.

- To establish methods and procedures to demonstrate and accurately quantify the energy and total cost savings realized with the adoption of simpler methods for SSM billet production compared to current methods.

## Progress and Milestones

This R&D project began in January 2002. Planned tasks include:

- Develop apparatus and processing techniques for liquid/liquid melt treatment, evaluate current status of alloys refined by Si-B additions and develop processing techniques for their application to SSM billet manufacturing.

- Evaluate the degree of microstructural modification and refinement obtained with the proposed methods. Control variables will be identified and the structure of SSM slurries produced by reheating grain-refined billets will be evaluated for quality, homogeneity.

- Evaluate grain-refined SSM feedstock using industrial forming equipment and carry-out a systematic investigation/measurement of cast properties.

- Employ computational and modeling studies to investigate slurry constants and slurry structure breakdown, which are experimentally difficult to do. Use constitutive models to identify, understand, and describe flow instabilities that occur during actual processing of slurries. Provide mechanisms to explain and control those instabilities, an important step to promote further commercialization of SSM technology.

### Project Partners

Worcester Polytechnic Institute
Worcester, MA

North American Die Casting Association
Rosemont, IL

Briggs & Stratton Corp., Milwaukee, WI
Daimler Chrysler, Auburn Hills, MI
Formcast, Inc., Denver, CO
Harley-Davidson Motor Co., Wauwatosa, WI
IdraPrince Co., Holland, MI
Intermet, Troy, MI
J.L.J. Technologies, Inc., Richmond, VA
Madison-Kipp Corp., Madison, WI
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